Patent application of

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for

MOBILE OBJECT WITH FORCE GENERATORS

FIELD OF THE INVENTION

The invention relates to vehicle technology and specifically to flying objects.

DISCUSSION OF PRIOR ART

All the recent man-made vehicles start and accelerate, speed up or slow down, with the help of either external force, or reaction force, or jet, or their combination. The vehicles are passive in relation to those forces, because the forces are external. Using the external thrusts confines motion possibility of the vehicles, since the vehicles need complex structures and specific conditions for their motion. For example, aircraft needs large wings and expensive airports for lifting and landing; helicopter needs very large blades of its rotor in comparison with its body. Both of them cannot fly at very high altitude because of decreasing of the air density along the altitude of the atmosphere. Spaceship needs an expensive starting complex and cannot accelerate any more after running out of fuel for jet propulsion. Therefore, the maximum speed of the man-made spaceships is very small in comparison with the light speed. On the earth surface ship needs sufficiently deep water to move, submarine cannot dive down too deep because of water pressure, automobile needs motorways, train needs railways, etc. Consequently, the

mankind's transport systems are very complicated, expensive, and constrained, and have low safety.

All the man-made vehicles are passive because their motion is based on Newton's laws of motion, in accordance with that the total of internal forces of each vehicle must be zero. However, the laws are stated only for solid bodies or systems of rigid particles and the total internal force may differ from zero for some bodies of other nature. For example, the sum of internal forces of a moving charged particle can differ from zero, although the sum is rather small. So far there has been virtually no exploration of any other body, which can generate a sufficiently large total internal force for practical application in vehicle technology.

OBJECTS AND ADVANTAGES

Accordingly, the main objects and advantages of my invention are to provide vehicles with mechanisms which allow the vehicles to generate their own total internal force that is their self-action force for starting, accelerating, lifting, landing, and moving in any direction in the air, cosmos, and water (if it is sealed), and on any ground surface and water surface (if the lower part of its body is sealed). The vehicles will make the mankind's transport system much more flexible, simple, cheap, safe, and faster in both the earth's environment and universe.

The above and another objects, advantages and features of my invention will become apparent following examination of drawings and ensuing description herein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic isometric view of a mobile object equipped with a force generator with a fragment of the shell of a generator chamber removed to show the arrangement of components of the force generator inside the generator chamber.

FIG. **2** is a side schematic view of the mobile object of FIG. **1** with the shell of the generator chamber removed.

FIG. **3** is a schematic plan view of a disk-stator of the force generator of the mobile object of FIG. **1**.

FIG. **4** is a schematic perspective view of a rotor of the force generator of the mobile object of FIG. **1**.

FIG. **5** is a diagram of relative position of the solid surfaces inside the mobile object of FIG. **1** with respective labels of the pressure distributions acting on them.

FIG. **6** is a diagram of the pressure distributions over the surfaces of the top disk of the rotor of FIG. **4** and the disk-stator of FIG. **3**.

FIG. **7** is a schematic perspective view of a modification of the rotor of FIG. **4**.

FIG. **8** is a schematic perspective view of a modification of the disk-stator of FIG. **3**.

FIG. **9** is a top plan view of a modification of the mutual pair of the rotor of FIG. **4** and the disk-stator of FIG. **3**.

FIG. **10** is a schematic sectional view of the mutual pair of the rotor and the stator of FIG. **9** taken on line **10-10**.

FIG. **11** is a schematic perspective view of an alternative mutual pair of rotor and stator.

FIG. **12** is the shape of dividing walls of the mutual pair of rotor and stator of FIG. **11**.

FIG. **13** is a schematic perspective view of another mutual pair of rotor and stator.

FIG. **14** is the shape of dividing walls of the mutual pair of rotor and stator of FIG. **13**.

FIG. **15** is a schematic side view of a ring-rotor.

FIG. **16** is a schematic top plan view of the ring-rotor of FIG. **15**.

FIG. **17** is a schematic sectional view of the ring-rotor of FIG. **15** taken on line **17-17**.

FIG. **18** is a schematic top plan view of a ring-stator.

FIG. **19** is a schematic front elevational view of an alternative force generator constructed on the base of a rotor of blades having an airfoil cross-section with a fragment of the shell of its generator chamber removed.

FIG. **20** is a schematic plan view of arrangement of force generators in a conventional aircraft.

FIG. **21** is a schematic side view of an aircraft with its rings removed being equipped with force generators for lifting and propulsion.

FIG. **22** is a schematic plan view of arrangement of the force generators in the aircraft of FIG. **21**.

FIG. **23** is a schematic side view of a mobile object having a flying saucer shaped body equipped with force generators.

FIG. **24** is a schematic sectional view of the mobile object of FIG. **23** taken on line **24-24** to show a schematic plan arrangement of its force generators and power devices.

FIG. **25** is an enlarged schematic side view of a turntable supporting force generators.

FIG. **26** is a schematic side view of an alternative mobile object equipped with force generators.

Fig. **27** is a schematic sectional view of the mobile object of FIG. **26** taken on line **27-27** to show a schematic plan arrangement of its force generators and power devices.

REFERENCE NUMERALS OF DRAWINGS

40 mobile object	42 force generator
44 engine	46 gearbox
48 generator chamber	50 structural frame
52 disk-stator	54 rotor
56 shaft	58 fan
60 fan duct	62 generator frame
64 central circular hole	66 hole
68 circumferential tube	70 top disk
72 open bottom	74 central tube
76 dividing wall	78 bearing
80 bearing	82 bearing housing
84 bearing housing	86 supporter
88 supporter	90 nut
92 washer	94 supporter
96 pulley	98 belt
100 shell	102 rotor
104 stator	106 circumferential tube
108 top disk	110 dividing wall
112 disk	114 circumferential tube
116 rotor	118 stator
120 exterior end	122 dividing wall

124 slit
126 circumferential tube
128 circumferential tube
130 rotor
132 disk-stator
134 dividing wall
136 trapezium
138 rotor
140 stator
142 dividing wall
144 curve
146 straight line
148 ring-rotor
150 circumferential tube
152 central tube
154 shaft tube
156 dividing wall
158 top ring
160 open bottom
162 rod
164 ring-stator
166 hole
168 mobile object
170 rotor of blades
172 generator chamber
174 shaft
176 supporter
178 supporter
180 structural frame
182 engine
184 gearbox
186 pump system
188 mobile object
190 aircraft
192 force generator
194 force generator
196 engine
197 mechanical transmission means
198 engine
199 mechanical transmission means
200 force generator
202 force generator
204 engine
205 mechanical transmission means
206 engine
207 mechanical transmission means
208 mobile object
210 aircraft with its rings removed
212 force generator
214 force generator
216 force generator
218 force generator
220 force generator
222 force generator
224 generator chamber
226 floor
228 engine
229 mechanical transmission means
230 engine
231 mechanical transmission means
232 engine
233 mechanical transmission means
234 engine
235 mechanical transmission means
236 engine
237 mechanical transmission means

238 engine
239 mechanical transmission means
240 rudder
242 cockpit
244 mobile object
246 flying saucer shaped body
248 passenger cabin
250 machine cabin
252 generator chamber
254 cockpit
256 structural frame
258 floor
260 ladder
262 door
264 window
266 suspension pier
268 wheel
270 photovoltaic panels
272 force generator
274 force generator
276 force generator
278 force generator
280 force generator
282 force generator
284 engine
285 selectively disengaging means
286 electrical motor
287 selectively disengaging means
288 mechanical transmission means
290 engine
291 selectively disengaging means
292 electrical motor
293 selectively disengaging means
294 mechanical transmission means
296 engine
297 selectively disengaging means
298 electrical motor
299 selectively disengaging means
300 mechanical transmission means
302 engine
303 selectively disengaging means
304 electrical motor
305 selectively disengaging means
306 mechanical transmission means
308 engine
309 selectively disengaging means
310 electrical motor
311 selectively disengaging means
312 mechanical transmission means
314 auxiliary power unit
316 pump system
318 special gateway
320 turntable
322 control motor
324 turning supporter
326 structural supporter
328 gearwheel
330 small gearwheel
332 hole
334 cylindrical shaft
336 bearing
338 bore
340 shaft
342 clutch
343 shaft
344 control unit

345 fuel tank
346 mobile object
348 body of aerodynamic shape
350 pilot cabin
352 machine cabin
354 rudder
356 structural frame
358 floor
360 lower section of a floor
362 glass screen
364 door
366 suspension pier
368 wheel
370 force generator
372 force generator
374 engine
376 mechanical transmission means
378 engine
380 mechanical transmission means
382 rectangular frame
384 shaft
386 strut
388 strut
390 hydraulic jack
392 hydraulic jack
398 engine
400 mechanical transmission means
402 control unit
404 fuel tank

SUMMARY OF THE PRINCIPLES OF THE INVENTION

In the present invention mobile objects including all types of vehicles are constructed on the base of the self-action principle of a solid-fluid body that has been discovered recently. Each of the mobile objects is presented as a solid-fluid body, which is a hermetically sealed solid chamber filled up with a fluid and containing a set of internal solid elements. The self-action principle states that a solid-fluid body except external forces is acted upon by a self-action force that equals to the sum of the time rate of change of the momentum of the whole fluid as a lump in free space and the total force due to the pressure and shear stress distributions of the fluid over the surfaces of its solid elements reduced by the force due to its body force. Therefore, in the case of absence of external forces each of the mobile objects can accelerate itself by using its self-action force. Since the self-action force is the total of internal forces of a solid-fluid body, the mobile object constructed on the base of the self-action principle can accelerate itself in any environment (in the atmosphere, water, cosmos, etc.) without the use of jets, reactive or external forces. The other advantage of the mobile object is that its self-action force can

be increases as many times as desirable due to increasing the pressure of the fluid that is usually a pressurized air or gas.

In order to produce large self-action forces for the mobile objects force generators, which are aerodynamic lift devices mounted inside the hermetically sealed solid chamber of each mobile object, are invented on the base of the technique of support of the gas on its lower surfaces in relative equilibrium. Each force generator comprises a rotary shell having an open bottom, the means supporting the gas in relative equilibrium inside said rotary shell, and the stationary means closing the open bottom of said rotary shell. The rotary shell and the means supporting the gas in relative equilibrium inside the shell constitute the rotor of the force generator. The special arrangement and strict coordination of said rotor and said stationary means supports the gas on the lower surfaces of the force generator, i.e. the rotary shell together with the stationary means, in relative equilibrium, while the relative velocity of the gas on its upper surfaces is proportional to the angular velocity of the shaft of its rotor. As a result, the force generator produces the maximum difference between the pressures of the gas acting on its lower and upper surfaces, i.e. the maximum lift.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, a mobile object constructed in accordance with one embodiment of the present invention is indicated generally at **40** in FIG. **1**. Mobile object **40** includes a force generator indicated generally at **42**, an engine **44**, a gearbox **46**, a generator chamber **48**, and a structural frame **50**. Force generator **42** comprises (see also FIG. **2**) a disk-stator **52**, a rotor **54**, a shaft **56** of the rotor, a fan **58**, a fan duct **60**, and a generator frame **62**. Disk-stator **52** (see also FIG. **3**) is a disk having a central circular hole **64** as a free space for assembly of the disk-stator and the shaft, and a hole **66** being the outlet of fan duct **60**. Rotor **54** comprises (see also FIG. **4**) a circumferential tube **68** having its upper end closed by a top disk **70**, an open bottom **72**, a central tube **74** for the shaft assembly, and dividing walls **76**. Dividing walls **76** extend from central tube **74** to circumferential tube **68** and from top disk **70** to open bottom **72** so that dividing walls **76** together with central tube **74** divide the inner space of rotor **54** into separate sections. Shaft **56** is supported by bearings **78** and **80** arranged in bearing housings **82** and **84**

respectively. The bearing housings **82** and **84** are secured to supporters **86** and **88** respectively. Disk-stator **52** and supporters **86** and **88** are secured to generator frame **62** of the force generator by screws or other suitable fasteners. Rotor **54** is mounted on shaft **56** and is secured by a nut **90** with a washer **92** on its top. Fan **58** is mounted to a supporter **94** being secured to generator frame **62** (or to structural frame **50**). Shaft **56** has a pulley **96** (or a gear) which together with a belt **98** (or a gear train) and a pulley (not shown) on the shaft (or a gear on the shaft) of fan **58** serves as a mechanical transmission means from shaft **56** of rotor **54** to the shaft of fan **58**. Generator frame **62** of the force generator is secured to structural frame **50** of mobile object **40** by welds or other suitable fasteners. The structure of shaft **56** provides such a position of rotor **54** that after the assembly of force generator **42** the clearance between the upper surface of disk-stator **52** and the plane of open bottom **72** of rotor **54** is as small as possible. Gearbox **46** is a mechanical transmission means from engine **44** to shaft **56**. Generator chamber **48** has a shell **100** being secured to structural frame **50** by a suitable means. Generator chamber **48** is filled with a working gas, which may be the air or any other gas. Engine **44** may be of turbo-prop, prop-fan, piston engine, or other types. The engine may be also an electrical motor, particularly when the solar energy is used. Engine **44** and gearbox **46** are secured to structural frame **50** by suitable means (not shown). Engine **44** in FIG. **1** is located outside shell **100** of generator chamber **48**. Engine **44** may be also situated inside generator chamber **48**. In that case the inlet and outlet passages of air flows and exhausted gases necessary for operation of the engine should be isolated from the working gas in generator chamber **48**. Rotor **54** can be made of aluminum alloy, steel, composite materials, or other suitable rigid materials. It is desirable to make the rotor as light as possible for the sake of saving energy. Disk-stator **52** can be made of aluminum alloy, steel, composite materials, or other rigid materials. Shell **100** can be made of steel or any other rigid materials, provided the shell can suffer the pressure of the working gas. In some applications generator chamber **48** may be pressurized. In that case generator chamber **48** is hermetically sealed and a means (not shown) for pressurizing the generator chamber may be powered from engine **44**.

In operation, rotor **54** and fan **58** are driven from engine **44** through gearbox **46**. During rotation of rotor **54** the working gas in the space bounded by disk-stator **52** and

rotor **54** rotates together with the rotor and sweeps over the upper surface of disk-stator **52** due to dividing walls **76** which skim the upper surface of disk-stator **52** to accompany the working gas. Whereby the working gas is supported in relative equilibrium inside rotor **54**. Because of the centrifugal force some part of the working gas in the space bounded by disk-stator **52** and rotor **54** is exhausted through the clearance between the upper surface of disk-stator **52** and the circumference of open bottom **72** or the bottom edge of circumferential tube **68** of rotor **54**. The exhausted gas is continuously compensated by the gas flows entering into the space bounded by disk-stator **52** and rotor **54** through fan duct **60** due to the operation of fan **58**. The rotation of rotor **54** creates different relative gas flows over the surfaces of disk-stator **52** and rotor **54**. The different relative gas flows, in turn, exert different pressures on the surfaces. As a result, the difference in pressure distribution over the lower and upper surfaces of disk-stator **52** and the difference in pressure distribution over the lower and upper surfaces of top disk **70** of rotor **54** exert forces on disk-stator **52** and rotor **54** respectively. The sum of the forces acts on mobile object **40** through the shaft, mechanical joints, fasteners, supporters, and structural frame of the mobile object in the upward direction along shaft **56** (from the lower surface to upper surface of the disk-stator or the top disk of the rotor). The sum of the forces generated by force generator **42** is the self-action force of mobile object **40**, since it is the internal force of the mobile object. The detailed discovery of the self-action force of mobile object **40** generated by its force generator **42** is explained by considering the pressure distributions of the gas flows over the solid surfaces inside mobile object **40**. FIG. **5** is a diagram of relative position of the solid surfaces inside mobile object **40**. The letter P with a subscript denotes the pressure distribution over each solid surface. P_1 and P_2 are the pressure distributions over the upper and lower surfaces of top disk **70** of rotor **54** respectively. P_3 and P_4 are the pressure distributions over the upper and lower surfaces of disk-stator **52** respectively. P_5 and P_6 are the pressure distributions over the inside and outside surfaces of circumferential tube **68** respectively. P_7, P_8, and P_9 are the pressure distributions over the surfaces of the ceiling, floor, and wall of generator chamber **48** respectively. Finally, we denote the static pressure in generator chamber **48** by P_0, that is the pressure in the state when force generator **42** is at rest. It is obvious that P_7 and P_8 are almost equal to P_0 and the resultant aerodynamic forces acting on mobile object **40** from

the pressure distributions **P_7** and **P_8** cancel each other. The resultant aerodynamic force acting on mobile object **40** from the pressure distribution **P_9** vanishes because of the symmetry of the pressure distribution. The resultant aerodynamic forces acting on the inside and outside surfaces of circumferential tube **68** of rotor **54** from the pressure distributions **P_5** and **P_6** respectively are equal to zero due to the geometric symmetry of the circumferential tube relative to the rotational axis of rotor **54**. Therefore, the resultant aerodynamic forces acting on mobile object **40** from the pressure distributions **P_1**, **P_2**, **P_3**, and **P_4** remain to be considered. FIG. **6** is a diagram of the pressure distributions over the upper and lower surfaces of top disk **70** (**P_1** and **P_2**) and disk-stator **52** (**P_3** and **P_4**). At a given angular velocity of rotor **54** the velocity at each point of the surface of top disk **70** is the angular velocity times the radius of the circle of the point's trajectory. The point's velocity is also the relative velocity of the gas flow above the circle with respect to the upper surface of top disk **70**. Therefore, the pressure distribution **P_1** over the upper surface of top disk **70** reduces with increasing of the radius denoted by **r** in FIG. **6**. In the figure **R** is the radius of circumferential tube **68**. The gas in the space bounded by stator **52** and rotor **54** rotates together with the rotor due to dividing walls **76** and, therefore, is supported in relative equilibrium. Consequently, the relative velocity of the gas flow inside rotor **54** with respect to the lower surface of top disk **70** is almost equal to (or a little greater than) zero. Therefore, the pressure distribution **P_2** over the lower surface of top disk **70** is almost constant and approximately equal to the static pressure **P_0**. Then the difference in pressure distribution, **P_2-P_1**, between the lower and upper surfaces of top disk **70** rises along the radius **r**. The difference in pressure, when multiplied by the area over which it acts, produces the force acting on top disk **70** or rotor **54** in the direction along the axis of the rotor from the lower surface to the upper surface of top disk **70**. The difference in pressure (**P_2-P_1**) gets its maximum value for every angular velocity of rotor **54**, since **P_2** is the pressure of the gas in relative equilibrium. While the gas in the space bounded by disk-stator **52** and rotor **54** rotates together with the rotor due to dividing walls **76**, disk-stator **52** is fixed. Therefore, the gas inside rotor **54** sweeps over the upper surface of disk-stator **52**. Then the relative velocity of the gas flow over the upper surface of disk-stator **52** increases with increasing of the radius **r**. Consequently, the pressure distribution **P_3** over the upper surface of disk-stator **52** reduces with increasing of the

radius **r**. Finally, the pressure distribution $\mathbf{P_4}$ over the lower surface of disk-stator **52** is almost constant and approximately equal to the static pressure $\mathbf{P_0}$, because the disk-stator is fixed, the volume of the exhausted gas per unit time may be made very small in comparison with the whole gas volume in generator chamber **48**, and the relative velocity of the gas flow over its lower surface is almost zero or in relative equilibrium. Then the difference in pressure distribution, $\mathbf{P_4}$-$\mathbf{P_3}$, between the lower and upper surfaces of disk-stator **52** rises along the radius **r**. The difference in pressure, when multiplied by the area over which it acts, produces the force acting on disk-stator **52** in the direction along the axis of rotor **54** from the lower surface to the upper surface of disk-stator **52**. The difference in pressure ($\mathbf{P_4}$-$\mathbf{P_3}$) gets its maximum value for every angular velocity of rotor **54,** since $\mathbf{P_4}$ is the pressure of the gas in relative equilibrium. The sum of the resultant aerodynamic forces created by the differences in pressure distribution, ($\mathbf{P_2}$-$\mathbf{P_1}$) and ($\mathbf{P_4}$-$\mathbf{P_3}$), is the force generated by force generator **42** in the direction along the axis of rotor **54** from the lower surface to the upper surface of disk-stator **52** or top disk **70**. The force is the thrust force generator **42** acts on the whole body of mobile object **40** through its shaft, mechanical joints, fasteners, supporters, and the structural frame of the mobile object in the upward direction along the axis of shaft **56**. The force generated by force generator **42** is the internal force of mobile object **40**, since it is defined only by interaction between the surfaces of the solid structure and the flows of the working gas inside the mobile object, that is the generated force is the self-action force of mobile object **40** and does not depend on the outer environment surrounding the mobile object.

Those skilled in the art know that in accordance with Newton's laws of motion the total of internal forces of a solid body or a system of solid particles vanishes. In other words, the discovery of the self-action force of mobile object **40** cannot be explained in the scope of Newton's mechanics. Therefore, for the sake of the precise and well-grounded discovery of the self-action force of mobile object **40** a new mechanics must be founded. For assertion of the discovery of the self-action force of mobile object **40** the fundamentals of the mechanics of solid-fluid bodies have been established and applied to the analysis of mobile object **40**. In the new mechanics mobile object **40** is considered as a whole mechanical system, which is called a solid-fluid body. The elaboration of the establishment is presented below.

Under a solid-fluid body we mean a hermetically sealed solid chamber filled up with a fluid and containing a set of internal solid elements. Suppose the solid-fluid body comprises N solid elements, among which its solid chamber is labeled as 1th solid element and its internal solid elements are labeled as 2nd to Nth solid elements. Then the momentum equation for the ith solid element can be written as

$$\frac{d}{dt}\vec{p}_i = \frac{d}{dt}m_i\vec{v}_i = \sum_j \vec{F}_{ij} + \vec{F}_i^{(p)} + \vec{F}_i^{(\tau)} + \vec{F}_i^{(e)}, \qquad i,j=1,2,\dots,N \qquad (501)$$

In Eq. (501) $\vec{F}_{ij}$ stands for the force on the ith solid element due to the jth solid element; $\vec{F}_i^{(p)}$ and $\vec{F}_i^{(\tau)}$ are the forces on the ith solid element due to the pressure and shear stress distributions of the fluid respectively over the surface of the ith solid element; and $\vec{F}_i^{(e)}$ is the total external force acting on the ith solid element.

Further, the momentum equation for the total fluid can be written in the integral form as follows

$$\frac{\partial}{\partial t}\oiiint_{v(t)}\rho(\vec{v}+\vec{V})dv + \oiint_{S(t)}(\rho\vec{V}.d\vec{S})\vec{V} = -\oiint_{S(t)} pd\vec{S} - \oiint_{S(t)}\vec{\tau}dS + \oiiint_{v(t)}\rho\vec{f}dv \qquad (502)$$

where $v(t)$ and $S(t)$ are the volume and boundary surface of the fluid respectively. They are time functions due to motion of the internal solid elements. The first term in the left side is the time rate of change of the momentum of the fluid due to motion of the fluid with the velocity $\vec{v}_0 = \vec{v} + \vec{V}$, in which $\vec{v}$ is the velocity of the whole solid-fluid body or the velocity of the solid chamber, $\vec{v} = \vec{v}_1$, and $\vec{V}$ is the velocity of the fluid particles relative to the solid chamber. The second term in the left side is the flow of momentum out of the space containing the fluid. The first term in the right side of the equation is the complete pressure force over the entire surface of the fluid. The second term in the right side is the shearing force, i.e. complete reaction of all the solid elements against the shear stress distribution of the fluid over them. The third term is the total body force exerted on the fluid.

The first term in the left side can be written as

$$\frac{\partial}{\partial t}\oiiint_{v(t)}\rho(\vec{v}+\vec{V})dv = \frac{d}{dt}\vec{p}_0 + \frac{\partial}{\partial t}\oiiint_{v(t)}\rho\vec{V}dv \qquad (503)$$

where the first term in the right side of Eq. (503) is the time rate of change of the momentum of the whole fluid as a lump in free space.

The surface of the fluid is confined to the surfaces of the solid elements. Therefore, the second term in the left side of Eq. (502) vanishes

$$\oiint\limits_{S(t)} (\rho\vec{V}.d\vec{S})\vec{V}) = 0 \tag{504}$$

Then summing the momentum Eq. (501) for all the solid elements with Eq. (502) for the fluid gives

$$\sum_{i=0}^{N} \frac{d}{dt}\bar{p}_i + \frac{\partial}{\partial t}\oiiint\limits_{v(t)} \rho\vec{V}dv = \sum_{\substack{i,j=1 \\ i\neq j}}^{N} \vec{F}_{ij} + \sum_{i=1}^{N} \vec{F}_i^{(p)} + \sum_{i=1}^{N} \vec{F}_i^{(\tau)} - \oiint\limits_{S(t)} pd\vec{S} - \oiint\limits_{S(t)} \vec{\tau}dS +$$

$$+\oiiint\limits_{S(t)} \rho\vec{f}dv + \sum_{i=1}^{N} \vec{F}_i^{(e)} \tag{505}$$

Applying Newton's third law for interaction between the solid elements and their interaction with the fluid yields

$$\sum_{\substack{i,j=1 \\ i\neq j}}^{N} \vec{F}_{ij} = 0 \tag{506}$$

$$\sum_{i=1}^{N} \vec{F}_i^{(p)} - \oiint\limits_{S(t)} pd\vec{S} = 0 \tag{507}$$

and

$$\sum_{i=1}^{N} \vec{F}_i^{(\tau)} - \oiint\limits_{S(t)} pd\vec{S} = 0 \tag{508}$$

Thus the momentum equation of the solid-fluid body must be written

$$\sum_{i=0}^{N} \frac{d}{dt}\bar{p}_i = -\frac{\partial}{\partial t}\oiiint\limits_{v(t)} \rho\vec{V}dv + \oiiint\limits_{v(t)} \rho\vec{f}dv + \sum_{i=1}^{N} \vec{F}_i^{(e)} \tag{509}$$

In Eq. (509) the term in the left side, which is the time rate of change of the total of the momentums of all the elements of the solid-fluid body in free space, must be equal to the total force acting on the solid-fluid body to accelerate it in free space; the second and third terms in the right side represent the total of external forces acting on the solid-fluid body. Therefore, the first term in the right side must be a force that the solid-fluid body acts on itself due to unsteady flow fluctuations of the fluid. We denote this force by $\vec{F}_s$, i.e.

$$\vec{F}_s = -\frac{\partial}{\partial t}\oiiint\limits_{v(t)} \rho\vec{V}dv \tag{510}$$

Substituting Eq. (501) for the time rate of change of the momentum of each solid element in Eq. (509) gives

$$\sum_{i=1}^{N}(\vec{F}_i^{(p)} + \vec{F}_i^{(\tau)}) + \sum_{i=1}^{N}\vec{F}_i^{(e)} + \frac{d}{dt}\vec{p}_0 = -\frac{\partial}{\partial t}\oiiint_{v(t)}\rho\vec{V}dv + \oiiint_{v(t)}\rho\vec{f}dv + \sum_{i=1}^{N}\vec{F}_i^{(e)} \qquad (511)$$

From Eqs. (510) and (511) we obtain

$$\vec{F}_s = -\frac{\partial}{\partial t}\oiiint_{v(t)}\rho\vec{V}dv = \sum_{i=1}^{N}(\vec{F}_i^{(p)} + \vec{F}_i^{(\tau)}) + \frac{d}{dt}\vec{p}_0 - \oiiint_{v(t)}\rho\vec{f}dv \qquad (512)$$

Then Eqs. (509) and (512) allow us to formulate the following

SELF_ACTION PRINCIPLE: *A solid-fluid body except external forces is acted upon by a self-action force,* $\vec{F}_s$, *equal to the sum of the time rate of change of the momentum of the whole fluid as a lump in free space and the total force due to the pressure and shear stress distributions of the fluid over the surfaces of its solid elements reduced by the force due to its body force, i.e.*

$$\vec{F}_s = \frac{d}{dt}\vec{p}_0 + \sum_{i=1}^{N}(\vec{F}_i^{(p)} + \vec{F}_i^{(\tau)}) - \oiiint_{v(t)}\rho\vec{f}dv \qquad (513)$$

We see that the self-action principle is equivalent to the momentum Eq. (509). Let us denote the relative velocity of ith solid element inside the solid-fluid body by $\vec{V}_i$, that is $\vec{V}_i = \vec{v}_i - \vec{v}$, and call the value $m_i\vec{V}_i$ its relative internal momentum. Then the momentum Eq. (509) can be written as

$$\left(\sum_{i=0}^{N}m_i\right)\vec{a} + \sum_{i=1}^{N}m_i\frac{d}{dt}\vec{V}_i = -\frac{\partial}{\partial t}\oiiint_{v(t)}\rho\vec{V}dv + \oiiint_{v(t)}\rho\vec{f}dv + \sum_{i=1}^{N}\vec{F}_i^{(e)} \qquad (514)$$

From Eqs. (512) and (514) we obtain the momentum equation of the solid-fluid body in the form

$$M\vec{a} = \sum_{i=1}^{N}(\vec{F}_i^{(p)} + \vec{F}_i^{(\tau)}) + \sum_{i=1}^{N}\vec{F}_i^{(e)} - \sum_{i=1}^{N}m_i\frac{d}{dt}\vec{V}_i \qquad (515)$$

where $M = \sum_{i=1}^{N}m_i$ is the total mass of all the solid elements of the solid-fluid body.

In order to assert the existence of the self-action force it is sufficient to consider a simple example described below.

Suppose a solid-fluid body is a hermetically sealed cylindrical solid chamber filled up with a fluid. Its cross-section area and length are A and l respectively. The cylindrical

chamber contains no internal solid element. The external force, $\vec{F}_1^{(e)}$, acting upon the chamber and the body force, $\vec{f}$, of the fluid are constant and have the same direction along its generatrix that lies on x-axis. The body force is uniform and the fluid is incompressible.

It is obvious that the shear stress is absent, $\vec{F}_1^{(\tau)} = 0$. The pressure along x-axis, i.e. the generatrix of the cylindrical chamber, can be found from the equation of fluid in relative equilibrium, that is

$$\frac{dp}{dt} = -\rho a \tag{516}$$

where ρ is the density of the fluid and a is the component of the acceleration of the cylindrical chamber in the direction of x-axis. Integrating the equation along the generatrix from 0 to l gives

$$p_l - p_0 = -l\rho a \tag{517}$$

where p_0 and p_l are the pressures of the fluid at the two ends of the cylindrical chamber.

Then the total force in the direction of x-axis due to the pressure distribution over the surfaces of the cylindrical chamber is

$$\vec{F}_1^{(p)} = \hat{i}A(p_l - p_0) = -Al\rho\vec{a} = -m_0\vec{a} \tag{518}$$

where $\hat{i}$ is the unit vector of x-axis.

Putting the total force $\vec{F}_1^{(p)}$ due to the pressure distribution over the surfaces of the cylindrical chamber and the body force $\vec{f}$ of the fluid into Eq. (513) gives the self-action force of the cylindrical chamber in the direction of x-axis

$$\vec{F}_s = \frac{d}{dt}\vec{p}_0 - m_0\vec{a} - Al\rho\vec{f} = -m_0\vec{f} \tag{519}$$

Eq. (519) shows that the self-action force of the cylindrical chamber always exists except the case of absence of the fluid or its body force. By analogy, it is easy to find the self-action force of solid-fluid bodies containing no internal solid element and having other shapes of their solid chambers. The above class of solid-fluid bodies is the class of simplest ones, since they contain no internal solid element. For solid-fluid bodies containing internal solid elements their self-action force can be increased very strongly due to interaction between their internal solid elements and fluid. The examples of

solid-fluid bodies containing internal solid elements are the mobile objects presented in this invention. The application of the self-action principle to analysis of their dynamics will be considered after establishment of the relationship of the self-action principle with Newton's laws of motion and the conservation law for momentum based on Newton's laws.

It is obvious that the existence of the self-action force has disproved Newton's second law for solid-fluid bodies, since the law ignores their self-action force. For illustration of the breakdown of Newton's second law we consider again the solid-fluid body of the above example, i.e. the cylindrical chamber. We now define the acceleration of the cylindrical chamber by using the momentum Eq. (515). The last term in the right side of Eq. (515) equals to zero, since the cylindrical chamber contains no internal solid element. Then putting the total force due to the pressure distribution of the fluid over the surfaces of the cylindrical chamber and the external force acting upon the chamber into Eq. (515) yields

$$m_1\vec{a} = -m_0\vec{a} + \vec{F}_1^{(e)} \tag{520}$$

Hence we obtain

$$\vec{a} = \frac{\vec{F}_1^{(e)}}{m_0 + m_1} \tag{521}$$

Formula (521) shows the true acceleration of the cylindrical chamber.

If the self-action force of the cylindrical chamber was ignored and its acceleration was defined by Newton's second law, its Newtonian acceleration, $\vec{a}_N$, would be

$$\vec{a}_N = \frac{m_0\vec{f} + \vec{F}_1^{(e)}}{m_0 + m_1} \tag{522}$$

Comparing the true acceleration $\vec{a}$ of the cylindrical chamber with its Newtonian acceleration $\vec{a}_N$ we see that, in general, the Newtonian acceleration differs from the true acceleration except the case of absence of the fluid or its body force.

The breakdown of Newton's second law implies the breakdown of Newton's first law for solid-fluid bodies, since the first law is a consequence of the second one.

The breakdown of Newton's second law implies also the breakdown of Newton's third law for solid-fluid bodies, since under the action of an interactive force, $\vec{F}^{\pm}$, between two solid-fluid bodies their resultant forces, $\vec{F}^1$ and $\vec{F}^2$, differ from each other due to the

difference between their self-action forces, which depend on their structure, that is $\vec{F}_1 = \vec{F} + \vec{F}_{1s}$ and $\vec{F}_2 = -\vec{F} + \vec{F}_{2s}$ imply $\vec{F}_1 \neq -\vec{F}_2$ if $\vec{F}_{1s} \neq -\vec{F}_{2s}$. For illustration of the breakdown of Newton's third law we consider the interaction between two solid-fluid bodies, each of which is the cylindrical chamber described in the above example. We denote the masses of the fluid and cylindrical chamber of the first solid-fluid body by m_{10} and m_{11} respectively, and the second solid-fluid body by m_{20} and m_{21} respectively. Then their body forces are

$$\vec{f}_1 = \frac{\vec{F}}{m_{10} + m_{11}} \tag{523}$$

and

$$\vec{f}_2 = -\frac{\vec{F}}{m_{20} + m_{21}} \tag{524}$$

Using formulae (519), (523), and (524) we obtain the self-action forces of the solid-fluid bodies

$$\vec{F}_{1s} = -\frac{m_{10}\vec{F}}{m_{10} + m_{11}} \tag{525}$$

and

$$\vec{F}_{2s} = \frac{m_{20}\vec{F}}{m_{20} + m_{21}} \tag{526}$$

Formulae (525) and (526) show that in general $\vec{F}_{1s} \neq -\vec{F}_{2s}$ except the special case when

$$\frac{m_{10}}{m_{10} + m_{11}} = \frac{m_{20}}{m_{20} + m_{21}} \tag{527}$$

Thus we have seen that all Newton's laws of motion have been broken down for solid-fluid bodies, although the laws were applied to description of the dynamics of their solid elements and fluid particles in the conclusion of the momentum equation and self-action principle of a solid-fluid body. In other words, Newton's laws of motion are satisfied for individual solid elements and fluid particles of a solid-fluid body, but they are broken down in the whole solid-fluid body due to solid-fluid interaction. Therefore, it is necessary to correct Newton's laws of motion for the sake of unifying the fundamentals of mechanics.

When a solid-fluid body moves in free space, only its external momentum can be watched from the outer, whereas its internal can be not. Therefore, we must differ them from each other. Its external momentum is the value

$$\vec{p}_{ext} = \left(\sum_{i=0}^{N} m_i \right) \vec{v} = (M + m_0)\vec{v} \tag{528}$$

Since $\vec{V}_i$ and $\vec{V}$ are relative velocities of the internal solid elements and fluid particles inside the solid chamber respectively, the internal momentum of the solid-fluid body can be defined as the value

$$\vec{p}_{\text{int}} = \sum_{i=2}^{N} m_i \vec{V}_i + \oiiint\limits_{v(t)} \rho \vec{V} dv \tag{529}$$

Then the momentum Eq. (514) can be written as

$$\frac{d}{dt}(\vec{p}_{ext} + \vec{p}_{\text{int}}) = \oiiint\limits_{v(t)} \rho \vec{f} dv + \sum_{i=1}^{N} \vec{F}_i^{(e)} \tag{530}$$

The momentum Eq. (530) differs from Newton's second law only in the presence of the internal momentum $\vec{p}_{\text{int}}$. Therefore, Eq. (530) allows us to formulate the following

GENERALIZED NEWTON'S SECOND LAW: *The time rate of change of the total of external and internal momentums of a solid-fluid body is directly proportional to the total of external forces acting on it and takes place in the direction of the total force.*

We see that the self-action principle and generalized Newton's second law are equivalent, since both of them are equivalent to the momentum equation of the solid-fluid body.

If the external momentum $\vec{p}_{ext}$ is constant, then from Eq. (530) we have

$$\frac{d}{dt}\vec{p}_{\text{int}} = \oiiint\limits_{v(t)} \rho \vec{f} dv + \sum_{i=1}^{N} \vec{F}_i^{(e)} \tag{531}$$

Eq. (531) allows us to formulate the following

GENERALIZED NEWTON'S FIRST LAW: *Every solid-fluid body continues in its state of rest or uniform motion in a straight line if the total of external forces acting on it equals to the time rate of change of its internal momentum.*

We notice that the sense of the interactive force in Newton's third law remains correct for solid-fluid bodies only if Eq. (530) or the generalized Newton's second law is applied to their dynamics. Therefore, we can formulate the following

GENERALIZED NEWTON'S THIRD LAW: *Whenever one solid-fluid body exerts a certain force on a second solid-fluid body, the second body exerts an equal and opposite force on the first and the time rate of change of the total of external and internal momentums of either body obeys the generalized Newton's second law.*

We see that the above generalized Newton's laws of motion are consequences of the self-action principle or momentum equation of a solid-fluid body. We notice that the original Newton's laws of motion are special cases of the generalized ones when the fluid is absent in bodies or their total internal momentum is constant. Now the reason of the breakdown of the original Newton's laws of motion for solid-fluid bodies is clear. Isaac Newton in his famous Principia, published in 1687, stated the laws of motion only for (absolutely) solid bodies. The condition of the (absolutely) solid state of the bodies allowed Newton to consider them as material points and ignore their internal momentums. From the Newton's times up to now his laws have been applied to any body with the neglect of its internal momentums. The self-action principle has discovered the existence of the time rate of change of the internal momentums of solid-fluid bodies and naturally returned them to the fundamental laws of motion. Therefore, the self-action principle does not contradict Newton's laws of motion, but has naturally generalized them for a wider class of bodies by including the internal momentums of the bodies in the laws. In other words, the mechanics of solid-fluid bodies is a natural generalization of Newton's mechanics of solid bodies.

One of the important consequences of the original Newton's laws of motion is the conservation law for momentum. For solid-fluid bodies its counterpart can be obtained from Eq. (530). If the total of external forces vanishes from Eq. (530) we have

$$\vec{p}_{ext} + \vec{p}_{\text{int}} = cont \tag{532}$$

or

$$\frac{d}{dt}\vec{p}_{ext} = -\frac{d}{dt}\vec{p}_{\text{int}} \tag{533}$$

Eqs. (532) and (533) allow us to formulate the following

CONSERVATION LAW FOR MOMENTUM OF A SOLD_FLUID BODY: *If the total of external forces is zero, the total of external and internal momentums of a solid-fluid body is conserved or the time rate of change of its external momentum is equal and opposite to the time rate of change of its internal momentum.*

We again see that the conservation law for momentum of a solid body based on the original Newton's laws of motion is a special case of the conservation law for momentum of a solid-fluid body when its fluid is absent or its total internal momentum is constant. The conservation law for momentum of a solid-fluid body is also a consequence of the self-action principle or momentum equation of a solid-fluid body. Therefore, the self-action principle does not contradict the conservation law for momentum of a solid body based on the original Newton's laws of motion, but has naturally generalized it for a wider class of bodies by including the internal momentums of the bodies in the law.

We now can apply the self-action principle or its consequences to the correct analysis of mobile object **40**. The symbols for the pressures used in the analysis are the same as shown in FIG. **5**.

It is obvious that the force due to the pressure and shear stress distributions over the side surface of generator chamber **48** vanishes. The forces due to the pressure distributions p_5 and p_6 over the internal and external side surfaces of circumferential tube **68** respectively also vanish due to their symmetry through the axis of shaft **56**. Suppose when rotor **54** is at rest the pressure, p_0, density, ρ_0, temperature, T_0, and total mass, m_0, or volume, v_0, of the gas in generator chamber **48** are known. We assume that when rotor **54** rotates with angular velocity ω the gas exhausted out of the rotor is compensated momentarily and the clearance between open bottom **72** and the upper surface of disk-stator **52** is such small that the gas inside rotor **54** can be considered almost as in relative equilibrium. In that case the pressure equation of the gas inside rotor **54** is

$$\frac{dp_2(r)}{dr} = \rho_2\omega^2 r = \frac{\omega^2}{RT_0} p_2(r)r \qquad (534)$$

where the positive direction of r is taken outward from the axis of shaft **56**. Solving Eq. (534) gives

$$p_2(r) = p_2(0)e^{\frac{\omega^2 r^2}{2RT_0}} \qquad (535)$$

Eq. (535) shows that the pressure inside rotor **54** depends not only on angular velocity ω, but also the pressure that is supported at the shaft inside rotor **54,** i.e. $p_2(0)$.

The gas mass, m_r, inside rotor **54** can be found by the integral

$$m_r = \int_0^{R_r} 2\pi h \rho_2(r) r dr = \frac{2\pi h p_2(0)}{RT_0} \int_0^{R_r} r e^{\frac{\omega^2 r^2}{2RT_0}} dr$$

where R_r and h are the radius and height of the rotor respectively. The integral gives

$$m_r = \frac{2\pi h p_2(0)}{\omega^2} (e^{\frac{\omega^2 R_r^2}{2RT_0}} - 1) \tag{536}$$

In the above integral and hereafter we ignore the radius of the shaft because of its smallness. Therefore, the above integral is taken from zero, but not from the radius of the shaft.

When the rotor rotates, the gas mass, m, outside the rotor is

$$m = m_0 - m_r = m_0 - \frac{2\pi h p_2(0)}{\omega^2} (e^{\frac{\omega^2 R_r^2}{2RT_0}} - 1) \tag{537}$$

Then the average density of the gas outside the rotor is

$$\rho = \frac{m}{v_0 - \pi R_r^2 h} \tag{538}$$

where $v_0 = \dfrac{m_0}{\rho_0}$ is the volume of the gas.

If q is the coefficient of compensation of the gas inside rotor **54** at the shaft, the pressure $p_2(0)$ at the shaft is

$$p_2(0) = qp = q\rho RT_0 \tag{539}$$

Solving the system of Eqs. (537)-(539) we obtain

$$\rho = \frac{m_0}{v_0 - \pi R_r^2 h + 2\pi hqD(E-1)} \tag{540}$$

where

$$D = \frac{RT_0}{\omega^2} \quad , \quad E = e^{\frac{\omega^2 R_r^2}{2RT_0}}$$

Since $m_0 = \rho_0 v_0$, $p_0 = \rho_0 RT_0$, and $p = \rho RT_0$, we have

$$p = \frac{p_0 v_0}{v_0 - \pi R_r^2 h + 2\pi hqD(E-1)} \tag{541}$$

We suppose that the upper surfaces of disk **70** and disk-stator **52** are such smooth that the gas flows over them can be considered as inviscid. The force due to the pressure

distribution over the surfaces of the dividing walls must be zero, since the gas inside rotor **54** is in relative equilibrium. Then according to Eq. (513) the self-action force of mobile object **40** is

$$\vec{F}_s = m_0\vec{a} + \sum_{i=1}^{4} \vec{F}^{(p_i)} - m_0\vec{f} \tag{542}$$

For calculation of the force $\vec{F}^{(p_1)}$ we consider an infinitesimal ring having the width dr and the inner radius r on the upper surface of the top end of the rotor. The area of the ring is $dS = 2\pi r dr$. Then the force acting upon the ring due to pressure p_1 is

$$d\vec{F}^{(p_1)}(r) = -\hat{k}2\pi p_1(r) r dr \tag{543}$$

where $\hat{k}$ is the unit vector of z-axis, which coincides with the axis of the shaft of the rotor.

We suppose the process is adiabatic, i.e. we do not provide or extract heat from the mobile object. Then we can use the energy equation and isentropic relationship for isentropic calorically perfect gas flows

$$C_p T_1(r) + \frac{V_1^2(r)}{2} = C_p T_0 \tag{544}$$

$$\frac{p_1(r)}{p} = \left(\frac{T_1(r)}{T_0}\right)^{\frac{\gamma}{\gamma-1}} \tag{545}$$

where p and T_0 are the pressure and temperature of the gas above the ring of radius r, and $V_1(r) = \omega r$. From Eqs. (544) and (545) we obtain

$$p_1(r) = p\left(1 - \frac{\omega^2 r^2}{2C_p T_0}\right)^{\frac{\gamma}{\gamma-1}} \tag{546}$$

Substituting formula (546) for $p_1(r)$ in the right side of Eq. (543) gives

$$d\vec{F}^{(p_1)}(r) = -\hat{k}2\pi p\left(1 - \frac{\omega^2 r^2}{2C_p T_0}\right)^{\frac{\gamma}{\gamma-1}} r dr \tag{547}$$

Summing the increments $d\vec{F}^{(p_1)}(r)$ along the radius r from 0 to R_r gives

$$\vec{F}^{(p_1)} = -\hat{k}2\pi p \int_0^{R_r} \left(1 - \frac{\omega^2 r^2}{2C_p T_0}\right)^{\frac{\gamma}{\gamma-1}} r dr \tag{548}$$

From the integrand of Eq. (548) we see that if

$$B = \frac{\omega^2 R_r^2}{2C_p T_0} < 1 \tag{549}$$

we can apply the binominal coefficients for the integrand. Taking the four fist coefficients gives

$$\vec{F}^{(p_1)} = -\hat{k}2\pi p \int_0^{R_r} \left(r - \frac{\gamma}{2(\gamma-1)} \frac{\omega^2 r^3}{C_p T_0} + \frac{\gamma}{8(\gamma-1)^2} \frac{\omega^4 r^5}{C_p^2 T_0^2} - \frac{\gamma(2-\gamma)}{48(\gamma-1)^3} \frac{\omega^6 r^7}{C_p^3 T_0^3} + \right.$$
$$\left. + \frac{\gamma(2-\gamma)(3-2\gamma)}{384(\gamma-1)^4} \frac{\omega^8 r^9}{C_p^4 T_0^4} \right) dr \tag{550}$$

The integral yields

$$\vec{F}^{(p_1)} = -\hat{k}\pi p R_r^2 \left(1 - \frac{\gamma}{2(\gamma-1)} B + \frac{\gamma}{6(\gamma-1)^2} B^2 - \frac{\gamma(2-\gamma)}{24(\gamma-1)^3} B^3 + \frac{\gamma(2-\gamma)(3-2\gamma)}{120(\gamma-1)^4} B^4 \right) \tag{551}$$

For the force acting on the infinitesimal ring of width dr and inner radius r of the lower surface of top disk **70** due to pressure p_2 we have

$$d\vec{F}^{(p_2)}(r) = \hat{k}2\pi p_2(r) r dr \tag{552}$$

Replacing $p_2(r)$ in Eq. (552) with expression (535) together with condition (539) gives

$$d\vec{F}^{(p_2)}(r) = \hat{k}2\pi q p e^{\frac{\omega^2 r^2}{2RT_0}} r dr \tag{553}$$

Then the total aerodynamic force acting on the lower surface of top disk **70** is defined by summing the increments $d\vec{F}^{(p_2)}(r)$ along the radius from 0 to R_r, we have

$$\vec{F}^{(p_2)} = \hat{k}2\pi q p \int_0^{R_r} e^{\frac{\omega^2 r^2}{2RT_0}} r dr \tag{554}$$

The integral yields

$$\vec{F}^{(p_2)} = \hat{k}2\pi q p D(E-1) \tag{555}$$

Further, the force acting on the infinitesimal ring of width dr and inner radius r of the upper surface of disk-stator **52** due to pressure p_3 is

$$d\vec{F}^{(p_3)}(r) = -\hat{k}2\pi p_3(r) r dr \tag{556}$$

Since the disk-stator is fixed, the relative velocity of the gas over its upper surface can be defined as $V_3(r)=\omega r^2$. Moreover, the pressure above the ring of radius r of its upper surface must be $p_2(r)$. Then by analogy to Eqs. (544)-(546) we obtain

$$p_3(r)=p_2(r)\left(1-\frac{\omega^2r^2}{2C_pT_0}\right)^{\frac{\gamma}{\gamma-1}} \tag{557}$$

Putting $p_2(r)$ from Eq. (535) and condition (539) into Eq. (557) gives

$$p_3(r)=qpe^{\frac{\omega^2r^2}{2RT_0}}\left(1-\frac{\omega^2r^2}{2C_pT_0}\right)^{\frac{\gamma}{\gamma-1}} \tag{558}$$

Substituting Eq. (558) into Eq. (556) gives

$$d\vec{F}^{(p_3)}(r)=-\hat{k}2\pi qpe^{\frac{\omega^2r^2}{2RT_0}}\left(1-\frac{\omega^2r^2}{2C_pT_0}\right)^{\frac{\gamma}{\gamma-1}}rdr \tag{559}$$

Summing the increments $d\vec{F}^{(p_3)}(r)$ along the radius r from 0 to R_r gives

$$\vec{F}^{(p_3)}=-\hat{k}2\pi qp\int_0^{R_r}e^{\frac{\omega^2r^2}{2RT_0}}\left(1-\frac{\omega^2r^2}{2C_pT_0}\right)^{\frac{\gamma}{\gamma-1}}rdr \tag{560}$$

If condition (549) is satisfied the integrand of Eq. (560) can be expanded by applying the binominal coefficients, we obtain

$$\vec{F}^{(p_3)}=-\hat{k}2\pi qp\int_0^{R_r}e^{\frac{\omega^2r^2}{2RT_0}}\left(r-\frac{\gamma}{2(\gamma-1)}\frac{\omega^2r^3}{C_pT_0}+\frac{\gamma}{8(\gamma-1)^2}\frac{\omega^4r^5}{C_p^2T_0^2}-\frac{\gamma(2-\gamma)}{48(\gamma-1)^3}\frac{\omega^6r^7}{C_p^3T_0^3}+\right.$$
$$\left.+\frac{\gamma(2-\gamma)(3-2\gamma)}{384(\gamma-1)^4}\frac{\omega^8r^9}{C_p^4T_0^4}\right)dr \tag{561}$$

Integrating the right side of Eq. (561) by parts we obtain

$$\vec{F}^{(p_3)}=-\hat{k}2\pi qpD\left(E-1-\frac{\gamma C}{2(\gamma-1)}[(R_r^2-2D)E+2D]+\frac{\gamma C^2}{8(\gamma-1)^2}[(R_r^4-4DR_r^2+\right.$$
$$+8D^2)E-8D^2]-\frac{\gamma(2-\gamma)C^3}{48(\gamma-1)^3}[(R_r^6-6DR_r^4+24D^2R_r^2-48D^3)E+48D^3]+$$
$$\left.+\frac{\gamma(2-\gamma)(3-2\gamma)C^4}{384(\gamma-1)^4}[(R_r^8-8DR_r^6+48D^2R_r^4-192D^3R_r^2+384D^4)E-384D^4]\right) \tag{562}$$

where

$$C = \frac{\omega^2}{C_p T_0} \tag{563}$$

Finally, the force due to the pressure acting upon the lower surface of disk-stator **52** is

$$\vec{F}^{(p_4)} = \hat{k}\pi R_r^2 p \tag{564}$$

We now determine the acceleration of mobile object **40** by putting the forces into Eq. (515). The last term in the right side of the equation vanishes because all the internal solid elements of the mobile object, i.e. their centers of mass, are stationary in relation to generator chamber **48.** Then from Eq. (515) we obtain

$$\vec{a} = \frac{1}{M}\left(\sum_{i=1}^{4} \vec{F}^{(p_i)} + \vec{F}^{(e)}\right) \tag{565}$$

where $\vec{F}^{(e)}$ is the total external force acting on the solid elements of the mobile object.

Substituting formula (565) for the acceleration $\vec{a}$ in Eq. (542) yields

$$\vec{F}_s = \left(1 + \frac{m_0}{M}\right)\sum_{i=1}^{4} \vec{F}^{(p_i)} + m_0\left(\frac{\vec{F}^{(e)}}{M} - \vec{f}\right) \tag{566}$$

In particular, when mobile object **40** is acted upon by a gravitational force, the body force of the gas, $\vec{f}$, equals to the acceleration of gravity, $\vec{f} = \vec{g}$, and the total external force acting on its solid elements equals to their total mass multiplied by the acceleration, $\vec{F}^{(e)} = M\vec{g}$. Then Eq. (565) becomes

$$\vec{a} = \frac{1}{M}\sum_{i=1}^{4} \vec{F}^{(p_i)} + \vec{g} \tag{567}$$

and Eq. (566) becomes

$$\vec{F}_s = \left(1 + \frac{m_0}{M}\right)\sum_{i=1}^{4} \vec{F}^{(p_i)} \tag{568}$$

Eq. (568) has proved that the self-action force of solid-fluid body **40** is defined by the pressure distributions over the lower and upper surfaces of top disk **70** and disk-stator **52.** Moreover, since $m_0 << M$, i.e. the mass of the gas is very small in comparison with the total mass of the solid elements, the term $\frac{m_0}{M}$ in Eq. (568) can be neglected. Then from

Eq. (568) we obtain the formula for calculation of the self-action force of solid-fluid body **40**

$$\vec{F}_s = \sum_{i=1}^{4} \vec{F}^{(p_i)} \tag{569}$$

where $\vec{F}^{(p_1)}$, $\vec{F}^{(p_2)}$, $\vec{F}^{(p_3)}$, and $\vec{F}^{(p_4)}$ are defined by formulae (548), (555), (560), and (564) respectively. In the case when the angular velocity and radius of rotor **54** satisfy condition (549) $\vec{F}^{(p_1)}$ and $\vec{F}^{(p_3)}$ can be calculated by formulae (551) and (562) respectively.

For illustration we suppose that mobile object **40** is filled with air. Then we have $\gamma = 1.4$ and $C_p = 1004.5 J/kg.K$. Assume that the temperature and pressure of the air at rest in mobile object **40** are given by the values $T_0 = 188K$ and $p_0 = 1.01 \times 10^5 N/m^2$, i.e. it equals to the pressure of the atmosphere at sea level. Putting the values of T_0 and C_p into unequalness (549) yields the condition for validity of Eqs. (551) and (562) for $\vec{F}^{(p_1)}$ and $\vec{F}^{(p_3)}$ respectively

$$\Omega R_r < 5800 \tag{570}$$

where Ω is the angular velocity of rotor **54** in rounds per minute (r/min). The coefficient of compensation is chosen equal to unit, $q = 1$. The volume of generator chamber **48** is $2m^2$ and the height of rotor **54** is $0.5m$. The values of the self-action force of mobile object **40** calculated by formula (569) for some values of the angular velocity and radius of rotor **54** are presented in table A. In the table the angular velocity is measured in r/min, the radius in meters, and the self-action force in Newtons.

In table A we see that force generator **42** with a relatively small radius (not greater than $1m$) of its rotor and at a not very high angular velocity (not greater than 5000r/min) can produce a very large lift. Those skilled in the art know that a lift device of other type (rotor of airfoil blades, lift disk, etc...) with the same sizes can produce a much smaller lift. The reason is that the increases in relative velocity of the gas on the lower and upper surfaces of a lift device of other type are almost the same when its radius or angular velocity increases. In contrary, when the radius or angular velocity of the force generator increases only the relative velocity on its upper surfaces increases, since the gas on its lower surfaces is in relative equilibrium. Therefore, the force generator produces the

TABLE A. The self-action force of mobile object **40** in Newtons

Ω / R_r	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
1000	2	34	172	543	1324	2741	5063	8591	13649	20557
1500	5	76	387	1222	2979	6156	11324	19087	30014	44544
2000	8	136	688	2175	5297	10914	19967	33340	51674	75134
2500	13	212	1076	3403	8278	16998	30876	50930	77474	109748
3000	19	306	1553	4909	11927	24388	43911	71339	106048	145591
3500	26	417	2118	6697	16250	33064	58904	93952	135875	179913
4000	34	545	2773	8774	21257	43006	75657	118054.	165339	210266
4500	43	691	2520	11146	26963	54194	93927	142808	192801	243763
5000	53	855	4360	13823	33389	66604	113400	167249	216741	252435

maximum difference between the pressures of the gas acting on its lower and upper surfaces, i.e. maximum lift.

The values of the self-action force presented in table A were calculated for the fixed pressure at rest $p_0 = 1.01 \times 10^5 N/m^2$ in generator chamber **48**. Formulae (569), (548), (555), (560), and (564) together with formula (541) show that the self-action force of mobile object **40** is proportional to the pressure p_0. Therefore, the self-action force of mobile object **40** can be increased further due to increasing the pressure p_0 in generator chamber **48**.

For the test of the self-action force produced by mobile object **40** its experimental model with the force generator having the rotor of $0.2m$ radius and $0.15m$ height has been built. An electrical motor of $3kW$ was used for driving rotor **54**. The self-action force was measured at angular velocity 3000r/min. The measurement of the self-action force was implemented by a weighing-scale that measured the weight of the mobile object at rest and at angular velocity 3000r/min. The volume of the generator chamber was $0.1m^3$, $0.2m^3$, and $0.5m^3$. For the first experiment some holes of the disk-stator were made for creation of the natural passages of air without any compensating gas means. The produced self-action force oscillated between 200 Newtons and 300 Newtons. The

produced self-action force was almost the same for the volume $0.1m^3$, $0.2m^3$, and $0.5m^3$ of the generator chamber. In the second experiment the volume of the generator chamber was $0.5m^3$, the angular velocity of the rotor was 3000r/min, different fans in a fan duct were used for the air compensation for the sake of reduction of the amplitude of oscillation of the self-action force. With the more suitable fans the produced self-action force oscillated slightly around 300 Newtons.

For testing the force generator alone, the generator chamber of the above experimental mobile object was removed. The lift of the force generator oscillated also slightly around 300 Newtons, that is it remains almost the same as in the case of the closure of the force generator in the generator chamber. For another test a force generator having a rotor of $0.5m$ radius and $0.45m$ height has been built. An electrical motor $13kW$ was used for driving its rotor. The lift of the force generator was measured at angular velocity 1400r/min. A compressor was used for the air compensation. The lift of the force generator oscillated slightly around the value 2670 Newtons.

So far we have considered the dynamics of the mobile object with one force generator. In general, each mobile object can include a plurality of the force generators. Then its self-action force is the total of the forces produced by all of its force generators. For example, if the mobile object comprises L force generators and the mass of the gas is ignored, its self-action force is

$$\vec{F}_s = \sum_{j=1}^{L} \vec{F}_{sj} = \sum_{j=1}^{L} \sum_{i=1}^{4} \vec{F}_j^{(p_i)} \tag{571}$$

where $\vec{F}_{sj}$ is the force produced by jth force generator. Then the acceleration of the mobile object is

$$\vec{a} = \frac{1}{M} \sum_{j=1}^{L} \sum_{i=1}^{4} \vec{F}_j^{(p_i)} + \vec{g} \tag{572}$$

where M is the total mass of all the solid elements of the mobile object and $\vec{g}$ is the gravitational acceleration.

If mobile object **40** operates in the atmosphere and the working gas is the air at the atmospheric pressure, the earth's atmosphere can serve as a generator chamber of mobile object **40**. In that case shell **100** may be removed or the generator chamber needs not to be pressurized. In FIGS. **1** and **4** rotor **54** has four dividing walls. In general, the number of dividing walls of the rotor may be chosen arbitrary from the conditions of the strength and

dynamic balance of the rotor. In FIGS. **1** and **2** force generator **42** has one fan in a fan duct. In general, the number of fans and, therefore, fan ducts, may be chosen arbitrary, provided they provide sufficient and almost momentary compensation of the exhausted gas. In FIG. **1** and **2** central tube **74** serves as an assembling member for assembly of shaft **56**. The central tube may be not necessary if dividing walls **76** extend directly from the shaft. Fan **58** in fan duct **60** is a compensating gas means for pumping the working gas into the space bounded by rotor **54** and disk-stator **52** to compensate the amount of the working gas exhausted out of that space due to the centrifugal force. For speeding the compensation process a compressor may be used instead of the fan in the fan duct. In some applications a hole through the disk-stator may be used as a compensating gas means. In that case the gas is sucked into the interior space of the rotor through the hole by natural way. Shaft **56** of rotor **54** of mobile object **40** shown in FIG. **1** is supported by bearing arrangement in both sides of the rotor. They may be also supported by bearing arrangement in one side of the rotor.

From the above consideration of operation of mobile object **40** and mathematical analysis of its dynamics we notice that force generator **42** produces the maximum difference between the pressures of the gas acting on its lower and upper surfaces, i.e. maximum lift, due to the special mutual structure of rotor **54** and disk-stator **52**, which support the gas in relative equilibrium inside the rotor and under the disk-stator. For supporting the gas in relative equilibrium rotor **54** includes the two basic physical features that distinguish from the rotors of other lift devices. The first distinguished physical feature of rotor **54** is the rotary shell that is constituted of circumferential tube **68** and top disk **70** and has open bottom **72**. The second distinguished physical feature of rotor **54** is a plurality of dividing walls that constitute a means supporting the gas in relative equilibrium inside the rotary shell during rotation of the shaft of rotor **54** when open bottom **72** is closed by disk-stator **52**. The disk-stator is a stationary means that closes open bottom **72** for implementation of two functions. The first function of disk-stator **52** is to constrain the gas in the rotary shell during rotation of the shaft of rotor **54**. The second function of disk-stator **52** is to produce the maximum difference between the pressures of the gas acting on its lower and upper surfaces, i.e. to support the gas on its lower surface in relative equilibrium. Thus disk-stator **52** is another distinguished physical feature of force generator **42** and together with rotor **54** constitute a mutual pair in the meaning of

their geometric structure. The basic feature of the geometric structure of the mutual pair of rotor **54** and stator **52** is the division of the space bounded by the rotor and disk-stator into separate sections such that the separate sections rotate together with rotor **54** and the uncovered lower edges of dividing walls **76** skim the upper surface of disk-stator **52**. The mutual structure of rotor **54** and stator **52** makes the working gas in the space bounded by the rotor and stator rotate together with rotor **54** and sweep over the upper surface of disk-stator **52**. In other words, in the mutual structure the rotor is an accompanying gas means for accompanying a gas volume sweep over a part of the surface of the disk-stator. Therefore, the geometric structure of the mutual pair of the rotor and disk-stator can be modified provided they have the basic feature of the geometric structure. For example, the mutual pair of rotor **54** and disk-stator **52** may be replaced by the mutual pair of a rotor **102** and a stator **104** illustrated in FIGS. **7** and **8** respectively. In FIG. **7** rotor **102** has a circumferential tube **106**, a top disk **108** and dividing walls **110**. In FIG. **8** stator **104** has a disk **112** and a circumferential tube **114**. Rotor **102** differs from rotor **54** by removing a lower part of circumferential tube **68**, i.e. rotor **102** has circumferential tube **106** being shorter than circumferential tube **68**. Stator **104** differs from disk-stator **52** by adding circumferential tube **114** to the upper surface of the disk-stator such that the added circumferential tube **114** fits the removed lower part of circumferential tube **68**. FIGS. **9** and **10** illustrate another mutual pair of a rotor **116** and stator **118**. Rotor **116** differs from rotor **54** by removing an exterior end **120** of the lower part of dividing walls **122** to create a slit **124** between a circumferential tube **126** and each of dividing walls **122**. Stator **118** differs from disk-stator **52** by adding a circumferential tube **128** such that the added tube **128** fits slit **124**.

From the illustrated above pairs of rotor and stator we notice that each pair of a rotor and a stator can be constructed by the following way. The rotor includes a shaft, a shell, and a plurality of dividing walls. The shaft has bearing supporters being secured to the generator frame. The dividing walls extend from the shaft and an upper part of the surface swept by the edges of the dividing walls due to their rotation about the axis of the shaft is covered by the shell (the upper part may include the full outer edges of the dividing wall and even a apart of the bottom edges). The shaft may be separate and the rotor has an assembling member for assembly of the shaft. The surface swept by the uncovered part of the edges of the dividing walls due to their rotation about the axis of the

shaft forms an open rotary surface of the rotor. The stator is a rigid member and has a fitting surface, which is a part of the surface of the stator that fits the open rotary surface of the rotor. The stator is secured to the generator frame and located under the rotor. The clearance between the open rotary surface of the rotor and the fitting surface of the stator is such small that the space bounded by the rotor and stator is divided into separate sections rotating about the axis of the shaft and the uncovered part of the edges of the dividing walls skims the fitting surface of the stator to accompany the working gas filling the space bounded by the rotor and the stator during rotation of the rotor. Whereby the working gas filling the space bounded by the rotor and the stator rotates together with the rotor and sweeps over the fitting surface of the stator during rotation of the rotor. For example, in the mutual pair of rotor **102** and stator **104** illustrated in FIGS. **7** and **8** each dividing wall **110** has a form of a rectangular plate. The shell includes circumferential tube **106** covering an upper part of the outer edges of the dividing walls and top disk **108** covering the upper end of circumferential tube **106** or the top edges of dividing walls **110**. The remained uncovered part of the surface obtained by rotation of each dividing wall **110** about the axis of the shaft of rotor **102** is the open rotary surface of rotor **102**. The interior surface of circumferential tube **114** and the part of the upper surface of disk **112** bounded by the bottom circumference of circumferential tube **114** constitute the fitting surface of stator **104** that fits the open rotary surface of rotor **102**. During rotation of rotor **102** the uncovered part of the edges of dividing walls **110** skims the fitting surface of stator **104**. For the other example, in the mutual pair of rotor **116** and stator **118** illustrated in FIGS. **9** and **10** the shell of rotor **116** also covers only an upper part of the edges of dividing walls **122**, since slit **124** exists between the remained uncovered part of the edges of the dividing walls and the lower part of circumferential tube **126**. Therefore, the open rotary surface of rotor **116** consists of the part of the surface swept by exterior edge **120** of the lower uncovered part of each dividing wall **122** due to its rotation about the axis of rotor **116** and the uncovered bottom surface of the rotor. Then the fitting surface of stator **118** consists of the interior surface of circumferential tube **128** and the part of the upper surface of the disk of the stator bounded by the bottom circumference of circumferential tube **128**. We notice that the geometric shape of each mutual pair of a rotor and a stator is defined by the form of dividing walls of the rotor. FIG. **11** illustrates the geometric shape of the mutual pair of a rotor **130** and a disk-stator **132**, which is defined by dividing walls

134 having the form of a trapezium **136** shown in FIG. **12**. FIG. **13** illustrates the geometric shape of the mutual pair of a rotor **138** and a stator **140**, which is defined by dividing walls **142** having the form consisting of a curve **144** and a straight line **146** shown in FIG. **14**.

In FIG. **6** we see that the difference in pressure on the surfaces at small radius is much smaller than that at large radius. Therefore, if the radius of a rotor is very large the central tube of the rotor may be made with a large radius too. In that case the hole of the central tube for the shaft assembly may be made shorter in order to reduce the weight of the rotor. Then the rotor has a ring cross-section. FIGS. **15** and **16** illustrate a schematic side view and a schematic top plan view of a ring-rotor **148**, which is a modification of the rotor shown in FIG. **4**. The cross-section perpendicular to the shaft of rotor **148** has a ring shape shown in FIG. **17**. In the figures ring-rotor **148** has a circumferential tube **150**, a central tube **152**, a shaft tube **154** for the shaft assembly, dividing walls **156**, a top ring **158** and an open bottom **160**. Dividing walls **156** extend from central tube **152** to circumferential tube **150** and from top ring **158** to open bottom **160**. Thus dividing walls **156** divide the space bounded by circumferential tube **150** and central tube **152** into separate sections. Central tube **152** is secured to shaft tube **154** by rods **162**. A ring-stator **164** shown in FIG. **18** together with ring-rotor **148** constitute their mutual pair. Ring-stator **164** has also a hole **166** for the outlet opening of a compensating gas means.

We notice that if disk-stator **52** of force generator **42** of mobile object **40** of FIG. **1** is removed, the difference in pressure distribution over the lower and upper surfaces of top disk **70** of rotor **54** still exists. Therefore, if generator chamber **48** is high enough such that the pressures at its ceiling and floor remain almost equal to the static pressure $\mathbf{P_0}$ during rotation of rotor **54** with disk-stator **52** removed, mobile object **40** still generates its self-action force. Of course the force generated by the rotor with the stator removed is too much smaller than the force generated by the force generator with the mutual pair the rotor and stator. The situation remains true for other types of rotor. Nevertheless, one special case is very interesting and useful. In that case a rotor of blades having an airfoil cross-section and being installed in a pressurized chamber can be used as a force generator.

Fig. **19** illustrates a mobile object, indicated generally at **168**, with a rotor of blades **170** having an airfoil cross-section and being installed in a hermetically sealed generator

chamber **172**. Rotor of blades **170** has a shaft **174**, which is supported for rotation by bearing supporters **176** and **178**. Bearing supporters **176** and **178** are secured to a structural frame **180** of mobile object **168**. Shaft **174** of rotor of blades **170** is operatively connected to an engine **182** by a gearbox **184**. A pump system **186** pressurizes a gas in generator chamber **172**. Pump system **186** is powered from engine **182**. Generator chamber **172** should be high enough such that the rotation of rotor **170** almost does not influence on the pressures at its ceiling and floor.

In operation, rotor of blades **170** is driven from engine **182** through gearbox **184**. Then the aerodynamic force or the lift created by rotor **170** can get a sufficiently large value due to the high pressure in generator chamber **172** and high angular velocity of rotor **170**. That force acts on the whole body of mobile object **168** through the shaft, mechanical joints, fasteners, supporters, and structural frame of the mobile object. Thus mobile object **168** generates its self-action force that also does not depend on the outer environment surrounding the mobile object. Mobile object **168** distinguishes from conventional helicopters by the independence of its self-action force from outer environment and the possibility of the operation of rotor **170** at high pressure that allows reducing the size of its blades and increasing its angular velocity.

We now apply the self-action principle presented earlier to the correct analysis of the dynamics of mobile object **168**.

Since the gas is compressible we write its equation in relative equilibrium in the form

$$\frac{dp}{dz} = -\frac{a}{RT}p \qquad (573)$$

The solution of the equation is

$$p(z) = p_1 e^{-\frac{a}{RT}z} \qquad (574)$$

where p_1 is the pressure of the gas on the floor of generator chamber **172**. If ρ_0 is the density of the gas at rest, then due to the conservation of mass we have

$$\rho_0 Al = \int_0^l A\rho(z)dz = \int_0^l \frac{Ap_1}{RT} e^{-\frac{a}{RT}z} dz = -\frac{Ap_1}{a}(e^{-\frac{a}{Rt}l} - 1) \qquad (575)$$

where l is the average height of generator chamber **172**. From Eq. (575) we have

$$p_1 = -\frac{l\rho_0 a}{(e^{-\frac{a}{RT}l} - 1)} \tag{576}$$

Substituting formula (576) for p_1 in Eq. (574) yields

$$p(z) = \frac{l\rho_0 a}{(e^{-\frac{a}{RT}l} - 1)} e^{-\frac{a}{RT}z} \tag{577}$$

From Eq. (577) we obtain the difference in pressure between the ceiling and floor

$$p_2 - p_1 = -l\rho_0 a \tag{578}$$

Then the force due to the pressure distributions over the ceiling and floor is

$$\vec{F}^{(p_1)} + \vec{F}^{(p_2)} = -\hat{k}Al\rho_0 a = -m_0\vec{a} \tag{579}$$

It is obvious that the total force due to the pressure and shear stress distributions over the walls of mobile object **168** vanishes. The force due to the pressure and shear stress distributions over the surfaces of blades of rotor **170** is its aerodynamic lift, $\vec{L}_R$. Then according to Eq. (513) the self-action force of mobile object **168** is

$$\vec{F}_s = m_0\vec{a} + \vec{F}^{(p_1)} + \vec{F}^{(p_2)} + \vec{L}_R - m_0\vec{f} = \vec{L}_R - m_0\vec{f} \tag{580}$$

The last term in the right side of Eq. (515) vanishes, since the center of mass of rotor **170** is at rest in relation to generator chamber **172**. Therefore, putting the corresponding forces into Eq. (515) gives

$$M\vec{a} = \vec{F}^{(p_1)} + \vec{F}^{(p_2)} + \vec{L}_R + \vec{F}^{(e)} = -m_0\vec{a} + \vec{L}_R + \vec{F}^{(e)} \tag{581}$$

where $\vec{F}^{(e)}$ is the total external force acting on all the solid elements of the mobile object.

From Eq. (581) we obtain the acceleration of mobile object **168**

$$\vec{a} = \frac{\vec{L}_R + \vec{F}^{(e)}}{m_0 + M} \tag{582}$$

In particular, when mobile object **168** is acted upon by a gravitational force, the body force of the gas, $\vec{f}$, equals to the acceleration of gravity, $\vec{f} = \vec{g}$, and the total external force is $\vec{F}^{(e)} = M\vec{g}$. Then Eqs. (580) and (582) become

$$\vec{F}_s = \vec{L}_R - m_0\vec{g} \tag{583}$$

and

$$\vec{a} = \frac{\vec{L}_R + M\vec{g}}{m_0 + M} \tag{584}$$

Formula (583) shows that the self-action force of mobile object **168** is almost equal to the lift $\vec{L}_R$ of rotor **170**, since the mass m_0 of the gas is very small in comparison with the mass of the mobile object and the gravitational force acting on the gas is very small in comparison with the lift of the rotor.

For testing the self-action force of mobile object **168**, the cross-section of the blades of rotor **170** was chosen such that the lift of rotor **170** was created only by the difference between the pressures of the gas acting on the lower and upper surfaces of the blades and the volume of the gas flowing downward during rotation of the rotor was as small as possible. With such cross-section of the blades, the self-action force of mobile object **168** was almost equal to the lift of rotor **170** when the height of generator chamber **172** was greater than three times of the radius of the rotor. When the height of generator chamber **172** decreased, the self-action force of mobile object **168** also decreased and was less than the lift of rotor **170**.

Formulae (583) and (584) show that the self-action force and acceleration of mobile object **168** are fully defined by the lift $\vec{L}_R$ of rotor **170** in the case of absence of gravitational force. Those skilled in the art know that the lift of a lift device increases when the pressure of the working gas increases. Therefore, the self-action force of mobile object **168** can be increased as many times as desirable by increasing the pressure of the gas inside generator chamber **172**.

Mobile object **40** can accompany a body or a vehicle. Then the motion direction of the vehicle can be controlled by controlling the direction of the shaft of the force generator of the mobile object. In order to cancel the reactive moment of the rotor of the force generator it is desirable to install in the generator chamber two identical force generators rotating in opposite directions. The value of the force generated by each force generator can be controlled by controlling the angular velocity of its rotor due to regulating the angular velocity of its driving engine and a brake (not shown) for braking its rotor in necessary situations. In general, each vehicle can be equipped with a plurality of the force generators and a space inside the vehicle can be used as a generator chamber of its force generators.

FIG. **20** illustrates a mobile object indicated generally at **188**, which is a conventional aircraft equipped with the force generators for vertical take-off and landing. Mobile object **188** comprises an aircraft **190** of any type, two identical force generators **192** and **194**, which are powered from engines **196** and **198** respectively. Engines **196** and **198** are mounted to the structural frame of the body of aircraft **190** outside the body thereof. Force generators **192** and **194** are vertically (with the vertical upward direction of generated forces) mounted inside the body of aircraft **190** and rotate in opposite directions. The shafts of the rotors of force generators **192** and **194** are operatively connected to engines **196** and **198** by mechanical transmission means **197** and **199** respectively. The air inside the body of the aircraft is used as the working gas for the force generators. Force generators **192** and **194** may be also powered from engines (not shown) of aircraft **190** if its engines are turbo-fan or turbo-prop. However, from the point of view of high safety for flying, force generators 192 and **194** are better powered from their own engines as shown in FIG. **20**. Since the air inside the body of the aircraft is used as the working gas, force generators **192** and **194** and engines **196** and **198** may be installed in any suitable location of aircraft **190**.

In operation, force generators **192** and **194** are driven from engines **196** and **198** through mechanical transmission means **197** and **199** respectively. The angular velocity of engines **196** and **198**, therefore and force generators **192** and **194**, are controlled by a control system (not shown) mounted in the cockpit (not shown) of aircraft **190**. During take-off force generators **192** and **194** lift aircraft **190** to a necessary height before starting its horizontal motion. During flying force generators **192** and **194** may be at rest or used to increase the height of the fly if it is necessary. During landing the force generators are controlled to provide a smooth vertical landing.

Mobile object **188** may be also equipped with force generators mounted horizontally (with horizontal orientation of their axes) for propulsion. In FIG. **20** force generators **200** and **202** are identical and mounted horizontally inside aircraft **190** for propulsion of mobile object **188**. Force generators **200** and **202** are powered from engines **204** and **206** respectively and rotate in opposite directions. The shafts of the rotors of force generators **200** and **202** are operatively connected to engines **204** and **206** by mechanical transmission means **205** and **207** respectively.

The use of force generators for lifting and landing of a conventional aircraft allows not only to increase its safety in flying, but also to remove its wings. If the wings of aircraft **190** are removed, mobile object **188** can fly at any altitude that does not depend on its speed. In that case either a conventional propulsion mechanism (not shown) or force generators **200** and **202** are used for propulsion.

Mobile object **188** is an aircraft of the combination of the force generator's technology with the conventional technology.

FIGS. **21** and **22** illustrate an alternative mobile object indicated generally at **208**, which comprises a conventional aircraft with its wings removed **210** and is equipped with force generators **212**, **214**, **216**, **218**, **220**, and **222**. Force generators **212**, **214**, **216**, and **218** are vertically mounted for lifting. Force generators **212** and **214** are identical and rotate in opposite directions. Force generators **216** and **218** are identical and rotate in opposite directions. Force generators **220** and **222** are identical, horizontally mounted for propulsion, and rotate in opposite directions. All the force generators **212**, **214**, **216**, **218**, **220**, and **222** are installed in a generator chamber **224** located under a floor **226** of aircraft **210**. The working gas in the generator chamber is the air. Force generators **212**, **214**, **216**, **218**, **220**, and **222** are powered from engines **228**, **230**, **232**, **234**, **236**, and **238** respectively. All the engines are mounted to the structural frame of the body of aircraft **210** outside the body thereof. The shafts of the rotors of force generators **212**, **214**, **216**, **218**, **220**, and **222** are operatively connected to engines **228**, **230**, **232**, **234**, **236**, and **238** by mechanical transmission means **229**, **231**, **233**, **235**, **237**, and **239** respectively. Mobile object **208** includes also a rudder **240**.

In operation, force generators **212**, **214**, **216**, **218**, **220**, and **222** are driven from engines **228**, **230**, **232**, **234**, **236**, and **238** through mechanical transmission means **229**, **231**, **233**, **235**, **237**, and **239** respectively. The angular velocities of engines **228**, **230**, **232**, **234**, **236**, and **238**, therefore and force generators **212**, **214**, **216**, **218**, **220**, and **222** are controlled by a control system (not shown) mounted in a cockpit **242** of aircraft **210**. Force generators **212**, **214**, **216**, and **218** are used for lifting and landing. Force generators **220** and **222** are used for propulsion. Mobile object **208** yaws by controlling horizontally mounted force generators **220** and **222**. Controlling the difference between the forces generated by force generator **220** and force generator **222** creates a necessary moment to

yaw mobile object **208** to the right or to the left. Mobile object **208** can also yaw by controlling rudder **240**. Mobile object **208** pitches by controlling vertically mounted force generators **212**, **214**, **216**, and **218**. Controlling the difference between the total force generated by fore force generators **212** and **214** and the total force generated by backward force generators **216** and **218** creates a necessary moment to pitch mobile object **208** upwards or downwards. Mobile object **208** rolls by controlling vertically mounted force generators **212**, **214**, **216**, and **218**. Controlling the difference between the total force generated by right force generators **212** and **216** and the total force generated by left force generators **214** and **218** creates a necessary moment to roll mobile object **208** to the right or the left. Since the air density does not influence on the operation of the force generators, mobile object **208** can fly at any altitude.

A mobile object being a conventional vehicle such as an automobile, a train, a ship, or a submarine can be also equipped with the force generators like the conventional aircrafts equipped with the force generators illustrated in FIGS. **20-22**. The number of equipped force generators for each vehicle is arbitrarily chosen in depending on the size and weight of the vehicle and the force each installed force generator can generate. In each vehicle some force generators are horizontally mounted for propulsion and some others are vertically mounted for lifting or diving. The vertically mounted force generators in each automobile, train, or ship direct their forces upward for lifting. The vertically mounted force generators in each submarine direct their forces downward for diving. Thus the automobile, train and ship equipped with the force generators can carry heavier weight or move faster. The submarine equipped the force generators can dive deeper and much easier maneuver in the depth.

FIG. **23** illustrates a mobile object, indicated generally at **244**, constructed in accordance with an alternative embodiment of the present invention. FIG. **24** is a schematic sectional view of mobile object **244** taken on line **24-24** in FIG. **23**. Mobile object **244** has a flying saucer shaped body **246** and includes a passenger cabin **248**, a machine cabin **250**, a generator chamber **252** and a cockpit **254**. The skin of body **246** is mounted to a structural frame **256**. The skin may be covered with a special protecting material for cosmos traveling. Passenger cabin **248** has a horizontal floor **258**, which behaves as a beam attached to structural frame **256** at its circumference. Machine cabin **250** has a ladder **260** for climbing up and down between cabins **248** and **250**. Passenger

cabin **248** has a plurality of doors **262**, a plurality of screen windows **264**. Mobile object **244** has suspension piers **266** for standing on the ground and wheels **268**, which are able to lower for running on the ground when it is necessary. Mobile object **244** is also provided with photovoltaic panels **270** for generation of solar electricity, which can be extended by a mechanism (not shown) mounted under the panels. Generator chamber **252** is filled with the air and pressurized and contains force generators **272**, **274**, **276**, **278**, **280**, and **282** (see FIG. **24**). All the necessary supporters of the force generators are secured to structural frame **256**. The shaft of the rotor of force generator **272** is operatively connected to an engine **284** or an electrical motor **286** by a mechanical transmission means **288**. Engine **284** is connected to mechanical transmission means **288** by a means **285** selectively disengaging the engine, and electrical motor **286** is connected to mechanical transmission means **288** by a means **287** selectively disengaging the motor. The shaft of the rotor of force generator **274** is operatively connected to an engine **290** or an electrical motor **292** by a mechanical transmission means **294**. Engine **290** is connected to mechanical transmission means **294** by a means **291** selectively disengaging the engine, and electrical motor **292** is connected to mechanical transmission means **294** by a means **293** selectively disengaging the motor. The shaft of the rotor of force generator **276** is operatively connected to an engine **296** or an electrical motor **298** by a mechanical transmission means **300**. Engine **296** is connected to mechanical transmission means **300** by a means **297** selectively disengaging the engine, and electrical motor **298** is connected to mechanical transmission means **300** by a means **299** selectively disengaging the motor. The shaft of the rotor of force generator **278** is operatively connected to an engine **302** or an electrical motor **304** by a mechanical transmission means **306**. Engine **302** is connected to mechanical transmission means **306** by a means **303** selectively disengaging the engine, and electrical motor **304** is connected to mechanical transmission means **306** by a means **305** selectively disengaging the motor. The shafts of the rotors of force generators **280** and **282** are operatively connected to an engine **308** or an electrical motor **310** by a mechanical transmission means **312**. Engine **308** is connected to mechanical transmission means **312** by a means **309** selectively disengaging the engine, and electrical motor **310** is connected to mechanical transmission means **312** by a means **311** selectively disengaging the motor. Machine cabin **250** is also equipped with an

auxiliary power unit **314** and a pump system **316** for pressurization of generator chamber **252** and passenger cabin **248**. There is a special gateway **318** between machine cabin **250** and generator chamber **252**. Force generators **272**, **274**, **276**, and **278** are identical and vertically mounted for lifting. Force generators **272**, **274**, **276**, and **278** are located at an equal distance from the central axis of the body of mobile object **244**, and at an equal distance from each other. The direction of rotation of the shafts of force generators **272** and **274** and the direction of rotation of the shafts of force generators **276** and **278** are opposite. Force generators **280** and **282** are identical and mounted horizontally on a turntable **320**. The shafts of force generators **280** and **282** are parallel, rotate in opposite directions and their generated forces have the same direction. The axis of turntable **320** coincides with the central axis of the body of mobile object **244**. This means that the shafts of force generators **280** and **282** are parallel to floor **258**, and the forces generated by force generators **280** and **282** have their direction perpendicular to the direction of the forces generated by force generators **272**, **274**, **276**, and **278**. Turntable **320** can turn on its axis any angle by the help of a control motor **322**. A structure of turntable **320** is shown in FIG. 25. Turntable **320** includes a turning supporter **324** and a structural supporter **326**. Turning supporter **324** is used for securing the frames of force generators **280** and **282**. Structural supporter **326** is secured to structural frame **256** and used for supporting turning supporter **324**. Turning supporter **324** has a gearwheel **328** underneath, which is driven for turning by a small gearwheel **330** of a gear train (not shown) driven from control motor **322**. The control motor is powered from auxiliary power unit **314**. Turntable **320** has a hole **332** at its center for the line of power transmission and a cylindrical shaft **334**. Turning supporter **324** is supported on a suitable bearing **336** for rotation on structural supporter **326**. Cylindrical shaft **334** rotates in a bore **338** of structural supporter **326**. Suitable sleeve bearing may be provided in bore **338**. For correct coordination of the operation of turntable **320** with the power transmission from engine **308** or electrical motor **310** to force generators **280** and **282** a shaft **340** rotating in hole **332** is jointed to a clutch **342** under the turntable. The flywheel of clutch **342** is jointed to a shaft **343**, which is the output of mechanical transmission means **312**. A control unit **344** including all the control panels and necessary steering tools of mobile object **244** is mounted in cockpit **254**. All the necessary mechanical, hydraulic, and electrical transmission lines and

circuits (not shown) connecting the control panels and steering tools of mobile object **244** with their objects such as the engines, actuators, motors, turntable, clutch, control motor, wheels and their brakes are mounted suitably in machine cabin **250** and generator chamber **252**. For supplying fuel to the engines fuel tanks **345** together a system of pumps and valves (not shown) are arranged in machine cabin **250** so that the center of gravity of mobile object **244** as closer to its center of gravity as possible. Mobile object **244** may be also provided with external drop fuel tanks (not shown). Hydraulic-mechanical systems (not shown) for lowering and braking wheels **268** of the mobile object are powered from auxiliary power unit **314**.

In operation, force generators **272**, **274**, **276**, and **278** are driven from engines **284**, **290**, **296**, and **302** through mechanical transmission means **288**, **294**, **300**, and **306** respectively or electrical motors **286**, **292**, **298**, and **304** through mechanical transmission means **288**, **294**, **300**, and **306** respectively. Force generators **280** and **282** are driven from engine **308** or electrical motor **310** through mechanical transmission means **312**. The angular velocities of engines **284**, **290**, **296**, **302**, and **308** or electrical motor **286**, **292**, **298**, **304**, and **310**, therefore and force generators **272**, **274**, **276**, **278**, **280**, and **282** are controlled by control unit **344**. Force generators **272**, **274**, **276**, and **278** lift mobile object **244** in the direction of the vertical axis of the mobile object. Force generators **280** and **282** thrust mobile object **244** in a direction perpendicular to the vertical axis of the mobile object. The instant direction of the thrusting force of force generators **280** and **282** is defined by the instant turning angle of turntable **320**, which is controlled by control motor **322**. Then mobile object **244** can implement any translation motion in space by combination of the lifting and thrusting forces. Mobile object **244** maneuvers by controlling the forces generated by force generators **272**, **274**; **276**, **278**, **280**, and **282** to create necessary moments. Mobile object **244** rolls about the axis of symmetry between the pair of force generators **272** and **274** and the pair of force generators **276** and **278** by creation of the difference between the total force generated by force generators **272** and **274** and the total force generated by force generators **276** and **278**. Mobile object **244** rolls about the axis of symmetry between the pair of force generators **272** and **278** and the pair of force generators **274** and **276** by creation of the difference between the total force generated by force generators **272** and **278** and the total force generated by force

generators **274** and **276**. Mobile object **244** rolls about the axis of symmetry between force generators **272** and **276** by creation of the difference between the force generated by force generator **272** and the force generated by force generator **276**. Mobile object **244** rolls about the axis of symmetry between force generators **274** and **278** by creation of the difference between the force generated by force generator **274** and the force generated by force generator **278**. Thus mobile object **244** can implement almost any maneuver in any direction in space by controlling force generators **272**, **274**, **276**, **278**, **280**, and **282**, and turntable **320**. When mobile object **244** flies at very high altitude or in cosmos, solar energy converted to electrical energy by photovoltaic panels **270** can be used for powering electrical motors **286**, **292**, **298**, **304**, and **310**. Particularly, in cosmos mobile object **244** can continue accelerate by using solar energy or universe energy up to desirable velocity and the fuel on board can be saved for emergencies. Since the value and direction of the self-action force can be controlled and do not depend on the air density, mobile object **244** can come out to the cosmos and return into the atmosphere smoothly.

Mobile object **244** shown in FIGS. **23** and **24** includes four vertically mounted force generators and two horizontally mounted force generators. In general, the number of equipped force generators and their arrangement in the mobile object can be chosen arbitrary. That depends on the characteristics of the equipped force generators and the mass, volume, and specific functions of the mobile object. For example, if force generators **274** and **278** of mobile object **244** are removed, the lift and the possibility of maneuver of the mobile object are reduced. For other example, if mobile object **244** is equipped with another additional pair of horizontally mounted force generators, the propulsion and the possibility of maneuver of the mobile object are larger. Since the forces generated by the force generators do not depend on the outer environment surrounding the mobile object, the shape of the body of the mobile object can be changed as desired. In other words, the shape of each mobile object equipped with force generators may be chosen arbitrary in depending on its specific purposes.

If a mobile object equipped with the force generators flies at a low altitude near the earth surface and its volume is desired to be as small as possible for a given passenger space, the number of the equipped force generators may be reduced by adding other members.

FIGS. **26** and **27** illustrate a mobile object, indicated generally at **346**, which is a small vehicle flying near the earth surface and serves as a flying car. Mobile object **346** has a body of aerodynamic shape **348** and includes a pilot cabin **350**, a machine cabin **352**, and a rudder **354**. The skin of body **348** is secured to a structural frame **356**. Pilot cabin **350** has a horizontal floor **358**, which behaves also as a beam attached to structural frame **356**. Floor **358** may have a lower section **360** if the pilot cabin is too small. Pilot cabin **350** has a glass screen **362** for pilot vision. A door **364**, which is a section of the top of the pilot cabin, has hinges (not shown) and can be closed-off for pilot climbing. Mobile object **346** has suspension piers **366** for standing on the ground and wheels **368**, which are able to lower for running on the ground when it is necessary. Mobile object **346** is equipped with force generators **370** and **372** (see FIG. **27**), which are arranged in machine cabin **352**. Thus machine cabin **352** serves also as a generator chamber, since the natural air in the atmosphere is used as a working gas for the force generators. The shaft of the rotor of force generator **370** is operatively connected to an engine **374** by a mechanical transmission means **376**. The shaft of the rotor of force generator **372** is operatively connected to an engine **378** by a mechanical transmission means **380**. Engines **374** and **378** are mounted in machine cabin **352**. Force generators **370** and **372** are identical and rotate in opposite directions. Force generators **370** and **372** are vertically mounted on the upper plane of a rectangular frame **382**. Frame **382** has a shaft **384**, which is supported by suitable bearings (not shown) arranged in struts **386** and **388**. Struts **386** and **388** are secured to structural frame **356**. One of the edges of frame **382** is operatively jointed with the tops of hydraulic jacks **390** and **392**, which control the angle between the upper plane of rectangular frame **382** and the horizontal plane. Hydraulic jacks **390** and **392** operate by the help of a pump **394** and a hydraulic circuit **396**. Pump **394** is operatively connected to an engine **398** by a mechanical transmission means **400**. Hydraulic jacks **390** and **392**, pump **394**, hydraulic circuit **396**, engine **398**, and mechanical transmission means **400** are secured to structural frame **356**. A control unit **402** including all the control panels and necessary steering tools of mobile object **346** is mounted in the front of pilot cabin **350**. Hydraulic mechanical systems (not shown) for lowering and breaking the wheels of the mobile object are powered from engine **398**. A fuel tank **404** is mounted in machine cabin

352 so that the center of gravity of mobile object **346** is as closer to the center of the mobile object as possible.

In operation, force generators **370** and **372** are driven from engines **374** and **378** through mechanical transmission means **376** and **380** respectively. Hydraulic jacks **390** and **392** raise or lower the edge of rectangular frame **382** jointed with their tops to give a desirable angle of the axes of force generators **370** and **372** relative to the horizontal plane. Then the total force created by force generators **370** and **372** is resolved into the vertical component and horizontal component. The vertical component is the lift of mobile object **346** and the horizontal component is the propulsion of the mobile object. Thus mobile object **346** can lift, hover in the air, and fly forward or backward by controlling the operation of force generators **370** and **372** and hydraulic jacks **390** and **392**. Mobile object **346** yaws by controlling rudder **354**. Mobile object **346** rolls by creating a difference between the lifting forces generated by force generators **370** and **372**. If a lower part of the skin of body **348** is sealed, mobile object **346** can sail on water surface. Mobile object **346** runs on the ground by wheels **368**. Thus mobile object **346** can take-off, hover in the mid-air, fly forward and backward, land, run on the ground, and sail on the water surface.

For increasing flying speed mobile object **346** may be further equipped with an additional propulsion mechanism that may be a horizontally mounted force generator (not shown) or a conventional propulsion mechanism (not shown).

From the foregoing, it will be seen that the present invention provides a new generation of vehicles. The distinguished advantage of the new vehicles is their ability to generate self-action forces, which do not depend on outer environment surrounding them. The advantage is achieved by equipping the vehicles with a plurality of force generators, which are principal components of the invention. The independence from outer environment makes the vehicles universal, much more flexible, and safer, and the infrastructure for their exploitation simpler and cheaper. The advantages of the force generators as propulsion mechanisms are their ability to be enclosed in any vehicle and generate very large forces from any source of energy, since any source of energy can be converted into rotational. The enclosure of the force generators makes the motion of the vehicles much more quiet than that of the conventional ones due to ability of damping noisy down to minimum.

An aircraft equipped with the force generators can take-off and land vertically, hover in space, fly at any altitude being independent of speed of flying, and implement flexible maneuvers. The vertical take-off and landing makes the aviation transport systems much more flexible, simpler, safer, and cheaper.

A flying car equipped with the force generators can take-off and land vertically, hover in the mid-air, fly forward and backward, implement flexible maneuvers, run on the ground, and sail on the water surface. The size of the flying car can be made sufficiently small as an automobile. Therefore, the application of the flying car can solve the jam problem of the traffic system on the ground.

A flying saucer equipped with the force generators is a universal vehicle in the earth's atmosphere and in the cosmos. The flying saucer can accelerate in any direction, implement very complicated maneuvers, come out to the cosmos and return in to the atmosphere smoothly.

A spaceship, which may be the above flying saucer, can continue accelerate in cosmos up to desirable velocity by using the solar or universe energy.

An automobile, a train, and a ship equipped with the force generators can carry heavier loads or move faster.

A submarine equipped with the force generators can dive deeper and maneuver easier in the depth.

A town in cosmos can be constructed as large as desirable by using a large number of force generators.

Flying robots for different purposes can be made by using the force generator's technology.

Accordingly, the main objects and advantages of my invention are to provide vehicles with mechanisms which allow the vehicles to generate their self-action forces for starting, accelerating, lifting, landing, and moving in any direction in the air, cosmos, and water (if it is sealed) and on any ground surface and water surface (if the lower part of its body is sealed). The vehicles will make the mankind's transport system much more flexible, simple, cheap, and faster in both the earth's environment and universe.

The foregoing description illustrates preferred embodiments of the invention. However, it will be apparent to those skilled in the art that the principles and concepts employed in such description may be employed in other embodiments without departing

from the scope of the invention. Accordingly, the following claims are intended to protect the invention broadly, as well as in specific forms shown herein.